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ABSTRACT

Designed for use in rural Ecuador, addition and multiplication bingo games which promote number recognition and fluency in arithmetic operations are described. These skills are necessary for successful transaction at the market place where rural Ecuadorians must be able to buy goods and make change. The leader calls out a mathematical problem and learners place a bean on the correct square of their board. The winner's results are checked by the rest of the class. It is possible to involve advance and lower-level learners in the same game by allowing advanced learners to shout out the answers which the slower learners look for on their boards. The author warns, however, that if slower learners dominate, the game quickly becomes boring for the advanced players. The games have proven popular and adaptations include community bingo games with prizes. Evaluation of this method of short term learning seems to indicate that when betting is allowed, measurable improvement in mathematics skills increases. The design of both the addition and multiplication games is included. (KC)

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TECHNICAL NOTE NO. 7

NUMBER BINGO

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GAME DESIGNED BY: PATRICO BARRIGA
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SO 011 574

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SUMMARY:

Addition and multiplication bingo promote fluency with number symbols and arithmetic operations. The leader calls out a problem, and learners seek the answer on their boards, placing a bean on the square containing the answer. The player first completing a row wins. Beginners concentrate on associating what they see with what they hear. Others learn new operations. Advanced students work for speed in computation.

This series of Technical Notes has been produced by staff members of the Ecuador Nonformal Education Project. Each note focuses on a particular issue or technique which has been developed and tested in Ecuador. The notes contain the information available at the time of writing and analytic comments based upon available evaluation data. However, the notes are in no way an evaluation of the project. Their purpose is to share ideas and information about new techniques as they are developed. Project staff want to encourage comments and suggestions from readers who may have had experience with similar techniques in other settings.

The project is financed by USAID and is a joint undertaking of the Ministry of Education in Ecuador and the Center for International Education at the University of Massachusetts. Ideas and materials derived from the ideas were created jointly by staff in Massachusetts and staff in Ecuador. All materials have undergone considerable change in the field as usage in various situations indicated needed modifications. The notes attempt to accurately credit the creators of each technique. In some cases, though, ideas have been modified by a variety of people and precise assignment of credit is difficult. In all cases, various members of the staff have made substantial inputs into the final version of the materials.

After three years of effort the number of people in Ecuador and in the United States who have made substantial contributions to this project is considerable. Rather than trying to enumerate the particular contributions of each, we will only note that this has been a genuine bi-national effort.

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BINGO

Fluency with numbers and adeptness with basic arithmetic operations are recognized as an important concern by the campesinos. In the action of the marketplace, they must first be able to recognize without hesitation the numbers on the bills and coins used to buy goods and to make change. To make decisions on which vendor to patronize they must be able to compare prices of similar goods. And, in order to avoid being short-changed, they must be able to rapidly compute the total cost of purchases without resorting to laborious paper and pencil calculations. How are the campesinos to develop these skills in a setting where formal education is a luxury beyond the reach of most of them?

Without access to effective schooling, many campesinos have failed to develop fluency in basic numerical skills. Many try to judge the values of banknotes by their color, and that of coins by their size. When adding or multiplying many campesinos must use their fingers or for more complicated sums rely on the seller to inform them of the total price. When adding 2 + 4, they may be tricked into paying 24 by a vendor who uses their slight knowledge of written number symbols to fool them.

In order to address these problems, the project has adapted the game

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The multiplication and addition bingo games were developed in the field by Patricio Barriga and James Hoxeng. The word bingo game was developed at the University of Massachusetts by Michael Haviland.

of bingo to teach number recognition and arithmetic operations. The two educational versions of bingo (addition bingo, and multiplication bingo) attempt to offer an exciting and challenging format for the repeated drilling necessary to develop skills in the recognition and manipulation of number symbols.

The bingo games underwent several revisions during their introduction in selected rural communities. The games were tested out in night-time learning groups consisting of from five to twenty-five learners. The players covered a wide range of age and skill levels. Children, who had only recently dropped out of school, could often be seen assisting their parents, who had forgotten whatever arithmetic they may once have learned. Communities have since taken the games out of this setting and used them in other ways. One group used multiplication bingo to raffle off prizes in a community fair. Other groups have used the games for gambling or recreation while drinking.

THE BASIC METHOD

Addition and multiplication bingo consist of cheap, locally reproducible materials:

1. Answer boards - cardboard sheets composed of squares containing solutions (either sums or products)
2. Problem cards - containing problems (either addition or multiplication) on one side, and the correct answer on the other
3. Seeds or small stones - which serve as markers on the answer board

The game leader provides each student with a game board, and a supply of seeds. The leader begins play by picking a problem card from the top of the deck and reading out the problem as he holds it up for the students to see.

Each game board contains different configurations of numbers. Those learners who are able to find the solution place a seed on the square containing that solution. Facilitators observe the learners' work, making necessary corrections and assisting the less advanced learners.

The person who first completes a row of seeds, whether horizontal, vertical or diagonal, is the winner. Winning demands both skill and luck. For if the numbers on the board are not favorably arranged, correct answers will not lead to completed rows.

The winners' results are checked with the rest of the class. The facilitator chants out the winners' solutions one by one, requesting confirmation from the class that each of those numbers did appear during the game.

If he calls out a number which no other player has covered with a seed, the winner will be challenged. For which problem did he choose this as the answer? The winner must prove he was right, or forfeit his claim to winning that round.

A step by step recounting of one version of the game may illuminate the various ways in which the games offer practice for the learners. This description relates to a session observed by the writer, in which

advanced learners played alongside middle-level and slower learners.

The leader read a problem card aloud, as he held the card in view of the learners. The learners heard and saw the problem simultaneously. Depending upon their skill level, players either learned or reinforced the association between the written and the oral number symbols. Next they performed the operation written on the problem card - some mentally, some by written computation. Having solved the problem, they sought the answer on their game board.

The more advanced learners quickly found the answer on their boards, and placed a seed over the corresponding square. They then shouted the answer, aloud. The leader then rotated the problem card to reveal the answer on the other side.

After giving the slower learners time to take in the written symbol, the leader confirmed orally the answer called out by the advanced learners. This gave the slower learners yet more time to associate what they saw with what they heard. As they looked for the answer on their own game board, they were forced to use <u>actively</u> the information which they had absorbed <u>passively</u>.

In addition to the information the slower learners received from the general environment, they were also given special attention by a second facilitator, who stood beside them as they worked on successive problems. He gave hints, encouragement, and when necessary corrected their mistakes. Individual attention proved especially valuable in

points of confusion. The game leader could not take time to explain that 6 and not 15 is the number symbol for the sum of 1 + 5.

The leader was more than occupied in maintaining the flow of the game - keeping the advanced learners from becoming bored, while not losing the slower learners. In fact, when slower learners predominate, the game can become boring for faster players. The competitive edge is lost. Players fail to notice when someone has reached bingo. The game drags on until all players have filled all squares.

The solution would seem to be to divide the group into sections. However, limitations on space and lighting do not often permit this. Instead, one facilitator had devised another solution. Faster players were seated on one side, slower players on the other, and middle-level players in the middle. Advanced players sometimes joked among themselves, sometimes assisted the middle-level players. Middle-level players tended to assist the beginners, and the beginners, grouped on one end were all within easy reach of the second facilitator.

The method seemed to work. Of the twenty players in the session observed by this writer, the facilitators maintained that twelve had known next to nothing three months ago. Now, there were only three players who still consistently had difficulty in addition and multiplication.

Using the game in this manner invites participation by players of varying skill levels. Cues can be taken orally or visually. To aid

the poorer players, facilitators reveal the reverse side of the problem card. The poorest players only have to match the figure on the card with the same figure on their game board. While these players cope with recognition and retention of number symbols, advanced players compete for speed in operations, and help middle-level players.

In groups of learners with a more narrow range of skill levels, the game is played differently. With a group of advanced players, the games become more competitive, and rapidly paced. With only slow learners, the problems may be dispensed with altogether in order to focus on number recognition and retention. The facilitator may hold up the answer side of the card and read the number out loud as the players seek that number on their boards.

FURTHER APPLICATIONS

Often it is necessary to spend considerable time with campesinos before they offer their own thoughts and experiences to an outsider. Only after observing a class, dining, and spending the night as a guest in a facilitator's house, was the writer told of one creative application of the bingo game outside of the learning groups.

On the night of May 3, 1972, the town of Tutupala had planned a fiesta. To make the party more interesting, and to raise money for a community store they were planning, the leaders of the town included a gambling bingo game. They set a charge for each game, and money was borrowed from the town cooperative to buy some modest prizes. Competition was

fierce, interest was high, and the town ended up with a small profit.

The informant stressed the excitement generated by this application of the bingo game. Due to the competitive air, poorer and middle-level players had selected themselves out. The pace was brisk. One cannot be sure, however, how much learning took place for the players that night. Did this session serve only as a public reward for past learning? Do the onlookers learn, when bingo is turned into a spectator sport? Do the onlookers feel a stimulus to improve their own proficiency in the game?

The project staff reports other instances of using the bingo games for raffles, and gambling. Even common household goods prove exciting when offered as a prize. In the cooperatives on the coast, players have competed for a straw hat, a notebook, a basket of fruit. One woman from the coast said she liked playing the bingo games more than attending the county fair. At the fair, you are among strangers. With the bingo games, you have fun in the community with your friends and relatives.

An Ecuadorean staff member feels that campesino culture does not generally sanction competition. Indigenous games rarely involve competition. Then why do people so enjoy competing in the bingo games? It may be the particular blend of chance and skill which campesinos like in the game. Perhaps games based exclusively on skill represent a threat to the ego of the average player.

For whatever reasons, it is sure that the game is very popular in most settings. In many communities where the project is working, bingo is one of the more popular games, often being played three times a week. Facilitators from one community reported that learners generally play six or seven rounds in one sitting before moving on to another game or method.

Project Field Coordinator, Enrique Tasiguano, was himself amazed at the manner in which parents were willing to be corrected by their children. In no other aspect of village life, he maintained, does one see such open cooperation and communication between generations. Further development of the game might take advantage of this phenomenon. If parents took copies of the game home, they might well seek help from their children. If children made copies of the game, and took them home, they might play with their parents.

GAME DESIGN

Adapting the bingo game to teach arithmetic skills might seem a trivial task. During the process of changing the board, the project staff unearthed a number of design issues, which may be of interest to future experimenters.

Addition Bingo

Addition bingo cards cover all the tables from 1 + 0 to 12 + 12. The answer boards are divided into five rows and five columns of five squares each. Twenty-four of the twenty-five spaces on the answer

board contain the numbers 1 through 24 - which include solutions to all problems from 1 + 0 to 12 + 12. The center square on the answer board is blank. Players completing rows, columns or diagonals passing through the center need solve only four problems instead of five. An alternate version could be played where for each round a different number was placed in the center square.

Any problem called out will have the solution available on every game board. Since all game boards have different configurations of the answers 1 to 24, some players will be able to produce a complete row, column or diagonal, before others.

The staff wanted each board to have an equal probability of winning. Random distribution of the numbers 1 - 24 on the board proved insufficient. All the numbers on the board do not, in fact, have an equal probability of appearing as a solution to a problem. The number 1 can appear only if the problem 1 + 0 is called. The number 12 can result from the problems 12 + 0, 11 + 1, 10 + 2, 9 + 3, 8 + 4, 7 + 5, 6 + 6. The number 12 is thus seven times as likely to appear on the answer board as the number 1. In fact, it turns out that all the numbers in the middle of the series 1 to 24 are much more likely to appear than the numbers on the extremes.

Unless care is taken, the odds are stacked in favor of certain boards with fortuitous configurations of the numbers in the middle of the series.

More frequent numbers can be placed on the edges of the board, so that they will appear in less rows, columns and diagonals than the numbers placed in the center of the board. Alternately, "loaded" answer boards could be produced on purpose, and given to the slower learners in order to increase their chances of winning.

Multiplication Bingo

The multiplication bingo cards cover the multiplication tables from 1 X 1 to 9 X 9:

	1	2	3	4	5	6	7	8	9
1	1	2	3	(4)	5	(6)	7	(8)	(9)
2		(4)	(6)	(8)	10	(12)	14	(16)	(18)
3			(9)	(12)	15	(18)	21	(24)	27
4				(16)	20	(24)	28	32	(36)
5					25	30	35	40	45
6						(36)	42	48	54
7							49	56	63
8								64	72
9									81

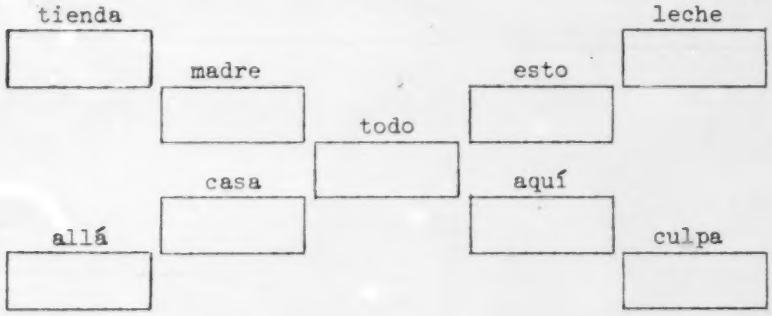
The numbers which repeat (indicated by circles on chart) were noted. Each game board was arranged so that the same number of repeating numbers would be included. In fact, boards with equal probability of winning will result only if repeating numbers are distributed carefully.

The multiplication bingo board has been divided into squares arranged in five rows, and eight columns. (See attached sample board.) Every other square in each row and column contains a number. In order to win, the player must fill in his entire board. Alternatively, in order to speed up the game, the facilitator can elect to have players fill in any four squares forming a straight line as a criterion for winning.

Word Bingo

Bingo games could be used to teach material other than numeracy. The staff has also devised a word bingo game, although this version has not received field testing.

In word bingo, everyday words are written on the cards. The same words occur on the boards, arranged in the following way:



In one game version, the group leader reads a word from a card. Players search for the word on their game boards and place a seed over the word once they find it. While slow learners practice recognition

of letters and master new words, faster learners practice words they know and gain fluency in translating spoken words into written letters. In order to help the beginners, the facilitator may hold up the word card for them to see as he reads the word. In order to motivate more advanced players, the facilitator may require that they write the words spoken on a blank board.

Clearly, the version of word bingo just described still needs development. Several different and more complex arrangements of words on the board would be needed. Alternate methods of use need to be developed. For instance, the game could be used with the Ashton-Warner approach to literacy (see Technical Note #5) by putting the words provided by the learners on the boards. One could also use the first names of participants to help maintain a sense of participation, as well as reinforcing the ability to write one's own name. Although not fully developed, the idea of word bingo has been included to give the reader a sense of the process used to create a new technique.

EVALUATION

Laboratories to evaluate multiplication bingo have been conducted in three rural communities. In each setting a pre-test was first administered in order to test the participants' abilities in the skills taught by the game. It proved a formidable task to design a test for evaluating only those skills, i.e. avoiding introduction of writing skills into a test. In this case the participants indicated their answers by crossing out the correct number with a pencil on their

bingo boards. (For discussion of the difficulties which arose in designing tests for marginally literate populations in rural settings, consult the Project Evaluation Report No. 1, which is available from the Ecuador Project.)

After the pre-test, one half of the participants were given a 40 minute initial exposure to the multiplication bingo game. The other half of the sample used a literacy game which did not teach arithmetic skills. This other group served as a control group. When the post-test had been administered to both groups, changes in the behavior of the bingo group could be compared with the performance of the group which had not used bingo. Both tests consisted of twenty multiplication pairs: fifteen pairs below nine, e.g., 5 X 9, and five more difficult pairs, e.g., 14 X 7.

Changes in ability levels reached statistical significance ($p < .05$) in only one of the three communities. These results were obtained in the one laboratory where betting was allowed during the playing of the bingo game.

From this the project staff has concluded that a brief exposure to the multiplication bingo game can produce measurable short-term skill improvement, if adequate ego involvement on the part of the players is provided for. In addition to betting and raffling prizes, other incentives will be designed for use in regularly scheduled night-time learning groups.

COST OF REPRODUCTION

The bingo games can be reproduced from sheets of light cardboard, magic markers and scissors. If these materials are not available, sheets of paper and pencils would also serve. The only substantial cost in reproducing the game would be the labor involved in lettering the cards and the answer board. If games were reproduced in the villages, learners could reproduce the games themselves in their leisure time. Paper and pencils would be the only cost of the game, under these circumstances.

CONCLUSION

The two mathematical forms of bingo have, in a short time, proved to be feasible, highly motivating, and generally effective. Despite the use of individual competition, a factor which seems to be largely absent in the traditional culture, the game has taken hold and is used frequently by preference of the learners. Evaluation of the short-term learning seems to indicate that when betting is allowed, measurable improvement in the mathematical skills occurs in a very short time. There remain a number of evaluation questions to be investigated in the future. Further versions of the game will probably develop - the most obvious being for subtraction and division. The word version is as yet in a development stage, but should ultimately prove useful.

SAMPLE BOARDS

(MULTIPLICATION)

	16		8		18		9
2		15		35		14	
	4		32		36		64
10		21		20		49	
	12		24		42		63

(ADDITION)

1	2	11	12	19
3	4	13	14	22
5	6		16	24
7	8	15	18	20
10	9	17	21	23

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